International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 5, Issue 4, Aug 2015, 59-68

IMPACT OF GOOD CROP MANAGEMENT ON THE SUSTAINABILITY OF SOIL RESOURCES IN THE OASIS OF OUARGLA

NAWEL OMEIRI & BAELHADJ HAMDI AISSA

Laboratoire de Biogéochimie des Milieux Désertiques, Faculté des Sciences de la Nature et de la vie, Université de Ouargla, Algeria

ABSTRACT

The study proposed in this paper is part of an interdisciplinary research work conducted in the oasis of Ouargla related to integrated soilfertility management.

The objective of this study is to characterize the impact of farming practices on threats oasis soils.

To meet the objectives of these terms of reference, we have adopteda systemic, interactive and participatory approach. Surveys and interviews were conducted with 15farmers according to their potential for protection and management of soilfertility in three stations chosen according to the level of degradation. Soil samples were taken for analysisat the laboratory. The analytical results obtained have allowed us based on a comparative approach to highlight the link between farmers 'practices and edaphic parameters related to salinity and fertility.

The analytical results of soil of three stations allowed us to confirm the observations of the field and verify the assumptions made about the quality of the soil in relation to the adoption or not of the main oasis farming practices identifiedduring the participatory diagnosis in the sense where it was found a negative parallelism between the mismanagement of these practices and the level of degradation.

The implementation of an integratedstrategyaiming at, the creation of the conditions which are necessary for the preservation of soilsfertility and the good management of the naturalresources as well as the improvement of the oasis system performance has nowbecome more urgent.

KEYWORDS: Degradation, Constraints, Salinity, Fertility, Durability, Management Plan

INTRODUCTION

Arid zones in the south of Algeria are forming a delicate ecological system in which the balance between climate, soil, water, air and vegetation is so fragile that rural population living in these areas is called to manage in adequate and timely manner in order to preserve and strengthen it.

The oasis of Ouargla, located in this harsh environment, is since the past, considered as one of the most prosperous oasis groups due to the community practices linked to the traditional system characterizing the ingenuity and the labor efforts mad by the Ouargli farmer.

Currently, the accumulation of sands, the rise of salt water tables and the huge loss of soils fertility and the absence of specificity considerations in the agricultural researches are the main grounds of such decline.

Handling the issue by the implementation of an integrated strategy looking, from one side, to create the necessary

conditions to set the preservation of soil fertility and good management of natural resources and, from the other side, to improve the oasis system performance, has now become more than urgent

The study proposed in this articlegoes into this direction, it allows from one side to examine the conditions of changing fertility levels and soil salinity in this specific and fragile oasis agro-ecosystem, explain causes of these changes related to peasant farming practices and climate change, and on the other side to optimize the use of this natural resource and seek possible ways to improve.

Our approach land is located in the south -east of Algeria in a basin with an area of 99,000 hectares with the following geographical coordinates: Height: 157m; Latitude: 32 ° 57 ' North; Longitude: 05 ° 20 ' East.

From west to east there are four sets geomorphological (Hamdi-Aissa and Girard, 2000):

- The plateau of the Hamada Pliocene on the west. On the east, it is strongly eroded, leaving the landscape in a series of outliers or Goures.
- The glaze on the western slope of the basin.
- Chott and sebkha are the lowest. The shallow is characterized by the presence of a permanent groundwater, very shallow (1 to 5m).
- Dunes, recent wind formations in small cords, occupy the east and northeast of Ouargla bordering the sebkhas along the Valley of OuedMya.

Ouargla climate is characterized by a well-marked aridity due to a lack of precipitations (35 mm / year), a high-contrast thermal regime, an excessive sunlight (3233heures / year) and a very high power of the air evaporating (3559.5mm / year).

All these characteristics can be used to explain some pedogenetic phenomena including: concentration, accumulation and retention of salts in soils of the region.

Furthermore, these characteristics can not explain only the current general decline in the natural environment potentialities in Ouargla. The steadily increasing pressure on lands used indiscriminately is causing the current situation.

MATERIALS AND METHODS

The Study Site

Extending over an area of623 hafor a number of 112 815 palm trees (CDARS, 2002), the palm of Ouargla where was conductedour study, issituated in the center of the city of Ouargla. Onefindstwo parts (Idder, 2005) :

- Eastern part: thisis the area of Beni Ouaguinecovering172.25 ha
- Western part: formed by two areas, that of Beni Brahim considered as the oldestand the largestwith301.1 ha, and that of Beni Sis sine covering an area of 145.81 ha

Methodological Approach

Thus, and starting from elements of reflexionabove- expressed and to respond to objectives set by the terms of reference, we have adopted a systemic, interactive and participatory approach related to Agricultural Research oriented towards the development "ARD" proposed by the International Center for Agricultural Research oriented towards

Development. Participatory approaches being considered as the most sustainable way to achieve long term objectives (Bilaro, 2007).

That said, the methodology followed to achieve this work was based on four (4) main phases:

Phase **I**: Research and basic documentary exploitation which focused on general information on Ouargla oasis and works which carried out therein.

Phase **II**: Exploring the environment through a participatory diagnosis of constraints related to the degradation of the soil environment through participatory survey based on Active Method of Participatory Research tools (focus groups, participatory map of resources, venn diagram.)

Thus, in this step we are organized to analyze with farmers and stakeholders, the situation submitted to them and present our conclusions in terms of realistic options of their research oriented towards development.

Surveys and interviews were conducted with 15 peasants according to their potentials for protection and management of soil fertility namely: the owners of the well embellished gardens, owners of medium maintained gardens and peasants have abandoned their gardens.

This step allowed us to collect more information on the realities of the organization of traditional oasis farms and farming practices.

During this phase we have also programmed to choose in consultation with farmers and agricultural services in the region, the stations intervention of our study.This choice depending on the level of soil degradation and was dictated to us by two main criteria: the physical status of the land and the piezometric level of groundwater. So are retained three stations each represented by three gardens.

On each station is collected as much information as possible to establish the link between especially good farming practices and the state of degradation.Thus, the first observations of the field have highlighted the following characteristics:

- Station 1: located at the edge of Chott and extending over an area of about 10ha in the area called " Tallan'oughlad",This station is representative of the gardens completely abandoned scoring a very advanced state of degradation of natural resources including the soil which shows the surface appearance of halomorphie problems (saline efflorescence) and waterlogging (congestion) because firstly the water table flush with the surface in winter and secondly to the lack of practical maintenance of these gardens are grown only very old date palm feet, poorly maintained and irrigated by a drilling debiting 40.48 l / s **(Figure 1)**

- Station 2: located in the area called " Timadhrayt " and extending over an area of about 50ha, this station has three gardens whose physical condition is estimated moderately degraded, marked in part by edaphic silting problems and salinity (salt efflorescence) in the presence of a water table at a depth of 1.3m, and also the problem of water shortage due to climate drought and low flow irrigation drilling (15l/s) relative to the served area.The culture system is represented by a substantially single culture constituting its frame, namely the date palm. Also, we noticed the lack of general maintenance of the palm **(Figure 2)**

- Station 3:represented by three well-kept gardens, located in the area called "Tingharyane ", occupying an area of about 20ha. They are the typical example of the palm three layers, that is to say, the date palms, fruit trees (including

pomegranates, fig trees) and herbaceous crops (vegetables and fodder). The surface appearance indicates good soil condition. This can be explained in part by the depth of the groundwater table exceeding three (3) meters, and regular maintenance work of the palm which is irrigated by a drilling miopliocène debiting 21.89 l / s **(Figure 3)**

This diagnosis is established, and for the characterization and monitoring in the area of soil quality of our study area, our approach was based on the installation in each garden of the three stations, three plots of 9 m2 placed randomized.Using an auger soil samples were collected at three points along three levels deep (0-20 cm, 20-40cm and 40-60cm) on each of three plots of each garden.Samples of each plot for each level were mixed to form an average sample per plot for three levels.Then, samples of the three plots were mixed to obtain each level a representative sample by garden.In all, 27 samples were formed to physico- chemical and biological laboratory analyzes using conventional methods of analysis.

In addition, the small size of our sample may be justified by the great heterogeneity of our field of study does not allow us a good command and control of all external factors also may influence the spatial evolution of soil quality which will make it difficult to verify our hypothesis about the impact of good crop management on soil quality.

Phase **III**: The analytical characterization of the level of salinity and fertility of soil samples collected was performed by standard methods of analysis commonly used in chemistry and biology labs of the soil, and covered:

- Physical aspect: the particle size according to the standardized protocol of the particle size fractionation AFNOR (1999);the total limestone acidimetrically through calcimeter BERNARD; gypsum by the conductivity method proposed by RICHARD in 1954

- Chemical aspect : soil reaction (pH) by the electrometric method using a pH meter with glass electrode calibrated with a known pH buffer solution; the EC byconductimère depending on the temperature of the cell constant; the determination of soluble salts (chlorides by the method argentometric MOHR (standard 90-0140) ; sulfates by gravimetric method (BS 1377 (199)); carbonates and bicarbonates acidimetrically with sulfuric acid (NFP standard 15- 461, 1964; ISO 9963-1)); the determination of soluble cations and exchangeable cations (Na and K by flame emission spectrophotometry using PFP7; Ca and Mg by atomic adsorption spectrophotometer) ; the nutrients (phosphorus (P2O5) by OLSEN method (extraction with sodium bicarbonate) - AFNOR standard X 31-116, potassium (K2O) by extraction with ammonium acetate - AFNOR standard X 31-108 ; the total nitrogen by the Kjeldahl method ; the trace elements by the methods of dissolving HF + HClO4

- Biological aspect: the rate of organic matter (OM %) deducted by the carbon content according to ANNE method (AFNOR X 31-109) ; the soil microbial biomass by respirometric methods

All the data collected was entered in the Excel spreadsheet and analysis of variance carried out with the software R. The separation of averages was done using the least significant difference (LSD) at the probability threshold of 5%. The statistical treatment of the data reveals that overall there are no significant differences between the results obtained in different parcels within the same station (standard deviation generally tends towards zero). For this purpose, in the result of our analysis, we will reason on the basis of average numbers obtained in each station.

Phase **IV** (Development): At the end of observations on the ground, the comments gathered through interviews with a group of farmers, information collected in the various institutions of research and development, we established a

general idea about the current situation and we made primarily to an overall analysis of the situation

The analytical results of the soil obtained allowed us secondly to deepen the analysis of data based on the assessment of land degradation status in accordance with the "harmonized" approach proposed by Brabant (2010)

RESULTS AND DISCUSSIONS

This article islimited to the study of peasant practices and their impact on the oasis soil. The analyticalresults are expressed on certain parametersrelated to salinity and fertility and concern surface horizons.

Determinants of Oasis Farming Practices and their Impact on the Ground

After identifying the three stations of the study area, our goal is to characterize the impact of farming practices on threatsaffecting oasis soils. Our processwasbased on the construction of indicators to estimate the effects of these practices on soilquality and monitor itsevolutions in order to identify, localize and quantify the degradation of itsfunctions and uses. This involves a first phase of identifying existing indicators.

Moreover, in synthesis report, it appears that we have not been able to identify indicators that directly evaluate the pressure of agricultural practices on most threats on the ground. Our process has been to summarize the relationship between each of farmers' practices and their potential impact on the ground.

The highlights of these practices determined by ingenious peasant knowledge that affects primarily fields of:

Water Control: The story of the oasis of Ouargla is inseparable from the water control. The Ouarglis have long remained faithful to gravity irrigation that permits the cultivation of vast surfaces.

Today, the irrigation method used throughout the palm grove is submersion. As this method of irrigation in the soil realizes a downward movement of water into the deeper layers, it promotes the leaching of solutes more superficial layers and is well suited for irrigation and remediation of saline soils or for the use of water containing a large amount of salts. This mode also causes considerable difficulties in the evacuation of excess water and thereby generates the thorny problem of drainage (Caliandro, 1998), especially if we know that the irrigation system for the most part is in bad condition causing considerable loss of water by infiltration. This percolation of water in depth causes a rise in groundwater and must be evacuated because the capillary rise from ground water is a source of salinisation in irrigated soils (Van Hoorn and Van Alphen, 1998). Drainage, either artificial or natural, is the obligatory irrigation supplement. It helps fight against excess water and agro-ecological and economic consequences.

Salinity Control: In order to solve partially this problem, some farmers realize in their palm groves massive inflows of sand dunes 20 to 30 cm thickness in order to give oxygen to the palm trees rising above the groundwater. This allows them to mask the problem of water logging and reduce the effect of salts and their concentration. In addition, the amendments by sand also possible to obtain fertile soil and cover the root surface portion exposed of irrigation water and wind (wind erosion).

Tillage: In the palm groves, interventions are generally carried out by hand with simple and effective tools (pickaxe, undermining, hoe...). Currently, farmers are looking more and more to minimize time spent working the soil, eliminating occasionally and sometimes permanently plow. The reasons that lead them to adopt these changes are varied: for economic reasons are added agronomic reasons (concentration of organic matter on the surface to increase the

structural stability). Furthermore, direct seeding widely used throughout the world and has been successfully tested in Algeria (Kheyar et al., 2011), is recommended in the conditions of the oasis

Improvement of Soil Fertility: The soils in traditional farms of Ouargla oases are poor in fertile material. When asked about the maintenance techniques and the soil fertility management, farmers felt "forced" to face questioning highlight banal practices that took their meaning: The spreading of farm manure, ashes and household waste; the use of crop residues: Waste date palm; associations of crops; rotation systems - crop rotation; fallow.

To fertilize the soil and prepare it for cultivation, the Ouarglis practiced slash and burn agriculture: indeed, after harvest and before performing the work of the soil, palm grove must be cleared of all of the debris, non-resumed discharges, dead or diseased trees and herbs. The unusable or infested wood debris are burned and ash that results is spread out on the floor. Once exhausted the soil, it will lie fallow during the time required for its fertility reconstitutes.

The most used material is the organic fertilizer from animal manure which is practiced every 5 to 10 or 20 years depending on the quality and quantity of intake. The human manure was also used. According Were (2007), it is an excellent soil conditioner that improves the intake of fertilizing elements while effectively regulating the heat and light used by plants. The addition of fertile arable land improves the quality of this manure thereby increasing nutrient content and water holding capacity of the soil. Therefore we will recommend to provide amendments of clay (bentonite) in too light soils to improve their cohesion and allow the formation of earthy aggregates (Halilat and Tessier, 2006).

The procedures for maintenance by organic manure appear somewhat subject to questioning. Thus, manure doses to be spread per hectare and per year, seem to be partly determined by a certain idea of optimal dose, corresponding to a non-discussed knowledge that a renewed calculation in each different situation. According to farmers this dose is approximately constant: in most cases it is the same on all parcels on the farm.

Impact of Peasant Farming Practices on Soil Quality

The various analytical results **(Table 1)**support the observations of the field and confirmed the assumptions made about the quality of the soil in relation to the adoption or not of the main oasis farming practices identified during the participatory diagnosis, in the sense that they express severe degradation levels the soils of the first station (high salinity, low fertility) where we noted the lack of good cultural practices against less stringent levels in the soils of the third station where farmers continue to maintain their gardens by good conduct crop.

Indeed, a comparison between the results obtained in these stations **(Figure 4)**we can see that it actually has a negative link between uncontrolled irrigation and salinity level. Thus, soils Station 1 marking the largest values of the EC and ESP surface (an EC 25.34dS / m for an ESP of 30.81 %) are subjected to the action of groundwater very salty and what actually constantly fed by the salty waters of irrational irrigation lack over there with an efficient drainage system and all other operations aimed, sanitation of the land and the protection of middle, making, we are left in the current state to big problems edaphic salinity and alkalinity as well as clogging of these soils

The opposite situation is found in the gardens of the station 3 where the EC soil does not exceed the 4.11dS / m. These soils are characterized not only by good natural drainage but also by good management of cultural practices through hydro land improvement (rational irrigation, leaching, sandblasting), combined with agrochemical and biological measures (making amendments and organic matter) for maintaining a tolerable level of salinity for most oasis crops.

The soils of the second station express the medium position of degradation with a fairly pronounced salinity level (6.2 dS / m) and whose causes can be attributed mainly to poor irrigation water (saline and sodic) applied without consider dose leaching and this because of water shortage problem in this station And in the absence of any measures to correct this imbalance by calcic and / or organic amendments, conservation work of soil and water, the salinization phenomenon can only get worse

Furthermore, in terms of fertility results collected **(Figure 5)** indicate that compared to land stations 1 and 2, those of the station 3 have the highest levels of physical fertility.

These soils are also characterized chemically by significant levels of nutrients when compared to soils of other stations. Except being noticed although the rates of organic matter are relatively low even compared to other land stations, which implies a C / N ratio is often low, so indicating a high organic matter mineralization rate paid to these soils.

However the soils of the station 2 and even more those of the station 1 in the absence of good agricultural practices suited to their agro -écologique context are now characterized by a very low level of fertility. Thus for soils from station 1 the problems of waterlogging and halomorphie caused as has already been mentioned by a non-mastered irrigation and the lack of an efficient artificial and natural drainage, caused in turn regression microbial activity. The research Dellal and Halitim (1992) demonstrate in fact that compared to non- saline soil densities of microbial populations in salty soils are relatively lower.However, waterlogging due to the high oxygen deficit and halomorphie inhibit the mineralization of organic matter, which tends to accumulate (Duchaufour, 2001) and this is what explains the OM values above in soil station 1 over other land other stations without these soils are enriched with other nutrients. For floors of the station 2 the lack of irrigation water also affects the soil organic matter that disappears by mineralization without a carbon return provided by the transformation of new plant residues. Deprived of organic matter and water, soil becomes very susceptible to wind erosion.

CONCLUSIONS

The diagnosis of the situation of traditionalcroppingsystems, thusestablishedthroughthisstudy in the oasis of Ouargla, which focused in particular on the fertility of soilsknown as "salty", allowed us among others effectively evaluate the impact of cultural practices on the sustainability of the edaphic component and this by identifying the fundamental relationshipsexpressing the current status of these soils in terms of salinity and fertility.

In sum, soiloases use strategieswereheavilyinfluenced by farmingknowledge. Despite the lack of expertise and resourcesthey have, the oasian farmers must solve the problem of improving the productivity of their land, for example by raisingsmall ruminants, adopting water recoverymethods and investing in affordable techniques for improvingsoilfertility. To sustainablyimprovefoodsecurity in thisregion, itisnecessary to integrate modern science intotraditionallivelihoodsystems. It shouldalso put in place a coherentsocio-economicpolicy to try to achieve the common objective of improving the productivity of marginal lands.

This exhaustive analysis allowed us to document in detail the performance enabled by a broad set of good agricultural practices developed through research and tested on-farm success (Sedogo 1993; Lompo 1995; Traoré and Stroosnijder, 2005, Traoré et al., 2007; Nacro et al, 2010; Roger- Estrade et al, 2011; Guyomard et al, 2013, Pouya et al, 2013) and that allowed us and ultimately to develop a plan Action for the integrated management of soil fertility of the oasis and the definition of a control approach against their degradation

REFERENCES

1. Bilaro AL, 2007. De nouvelles approches pour les zones infécondes connaissent l'insécurité alimentaire. *Agriculture et développement rural* 14(2) : 48-50.
2. Brabant P, 2010. *Une méthode d'évaluation et de cartographie de la dégradation des terres. Proposition des directives normalisées*. Montpellier (France): CSFD.
3. Caliandro A, 1998. *Les variables et les méthodes d'irrigation : aspects agronomiques.* Bari (Italie): IAMB.
4. CDARS (Commissariat au Développement Agricole des Régions Sahariennes), 2002.*Fiche signalétique de Ouargla (quelques chiffres)*. Ouargla (Algérie) : CDARS
5. Dellal A, Halitim A, 1992. Activités microbiologiques en conditions salines : cas de quelques sols salés de la région de Rélizane (Algérie).*Cahiers Agricultures* (1) : 335-340.
6. DuchaufourPh,eds, 2001. *Introduction à la science du sol*. Paris: DUNOD.
7. Guyomard H, Huyghe C, Peyraud JL, Boiffin J, Coudurier B, et *al.*, 2013.*Vers des agricultures à hautes performances. Volume 3 : Evaluation des performances de pratiques innovantes en agriculture conventionnelles*. Paris : INRA.
8. Halilat MT, Tessier D, 2006.Amélioration de la rétention en eau de matériau sableux par ajout de bentonite. *Cahiers Agriculture* 15 (4) : 347-353.
9. HamdiAissa B, Girard MC, 2000.Utilisation de la télédétection en régions sahariennes, pour l'analyse et l'extrapolation spatiale des pédopaysages. *Sécheresse* 11 (3): 179-188.
10. Idder M.T., 2005.*Contribution à l'étude des principaux facteurs de dégradation de l'oasis du ksar de Ouargla.*Mémoire d'Ingénieur: Universitéde Ouargla (Algérie).
11. Kheyar MO, Mouhouche B, Mahdi M,2011. Tests of direct sowing of the durum wheat under pivot in the Saharan zone: Influence on yield components. *Journal of Horticulture and Forestry* 3(11): 342–346.
12. Lompo F, 1995. *Etude de cas au Burkina Faso de l'initiative phosphates naturels.* Burkina Faso: INERA.
13. NacroS, Ouedraogo S, TraorK, Sankara E, Kabore C, Ouattara B, 2010. Effets comparés des pratiques paysannes et des bonnes pratiques agricoles de gestion de la fertilité des sols sur les propriétés des sols et les rendements des cultures dans la zone sud soudanienne du Burkina Faso.*International Journal of BiologicalandChemical Sciences* 4(4) : 1044-1055.
14. Pouya MB, Bonzi M, Gnankambary Z, Traoré K, Ouédraogo JS, Somé AN, et *al.*,2013. Pratiques actuelles de gestion de la fertilité des sols et leurs effets sur la production du cotonnier et sur le sol dans les exploitations cotonnières du Centre et de l'Ouest du Burkina Faso. *Cahiers Agricultures* 22 : 282-92.doi : 10.1684/agr.2013.0643.
15. Roger-Estrade J, Labreuche J, Richard G, 2011. Effets de l'adoption des techniques culturales sans labour (TCSL) sur l'état physique des sols : conséquences sur la protection contre l'érosion hydrique en milieu tempéré. *Cahiers Agricultures*20 : 186-93. doi : 10.1684/agr.2011.0490.
16. Sedogo MP,1993. *Evolution des sols ferrugineux lessivés sous culture: influence des modes de gestion sur la fertilité.* Thèse de Docteur Es –Sciences, Université Nationale de la Côte d'Ivoire, Abidjan (Côte d'Ivoire).
17. TraoréK, Stroosnijder L, 2005. Sorghum quality, organic matter amendments and health farmers' perception in Burkina Faso.*West Africa Ecology of Food and Nutrition* 44: 25–245.
18. TraoréO, Traoré K, Bado BV, Lompo DJP, 2007. Crop rotation and soil amendments: impacts on cotton and

maize production in a cotton based system in western Burkina Faso. *International Journal of Biological and Chemical Sciences* 1(2): 143-150.

19. Van Hoorn JW, Van Alphen JG, 1998.*Maîtrise de la salinité, bilan de sels et besoins de lessivage des sols irrigués*. Bari (Italie):IAMB.
20. Were E,2007. Le recyclage des déchets humains au service de la sécurité alimentaire. *Agriculture et développement rural* 14(2):58-61.

Table 1: Analyticalcharacterization of Soils of Study Stations

Station	pH	EC (dS/m)	ESP (%)	OM (%)	N (%)	C/N	K_2O (ppm)	P_2O_5 (ppm)	OE (ppm)	BM (µg/g)
1	7.26 +/- 0.12	25.34 +/- 1.63	30.81 +/- 0.29	0.93 +/- 0.02	0.046 +/- 0.008	11.8 +/- 0.28	22 +/- 0.02	23.01 +/- 0.04	41.05 +/- 0.04	25.43 +/- 0.68
2	7.65 +/- 0.04	6.11 +/- 0.02	8.99 +/- 0.81	0.676 +/- 0.004	0.036 +/- 0.004	11.02 +/- 1.64	29.99 +/- 0.03	43 +/- 0.02	73.09 +/- 0.08	37.5 +/- 0.08
3	7.85 +/- 0.07	4.11 +/- 0.07	5.41 +/- 0.06	0.34 +/- 0.05	0.056 +/- 0.005	3.65 +/- 0.84	37.99 +/- 0.04	62.94 +/- 0.05	170.04 +/- 0.03	45.33 +/- 0.12
P ANOVA	0.838	0.042	0.059	0.008	0.147	0.033	0.09	0.085	0.014	0.383

OM : OrganicMatter
N: Total Nitrogen
OE :Total Oligoelements: ∑ de Mn + Cr + Pb + Cd + Cu + Ni
MB : Total MicrobialBiomass

Figure 1: Garden Degradedbordering Chott

Figure 2: Garden Moderatelydegraded "withouttoilet"

Figure 3: Garden in Good Condition, Wellmaintained

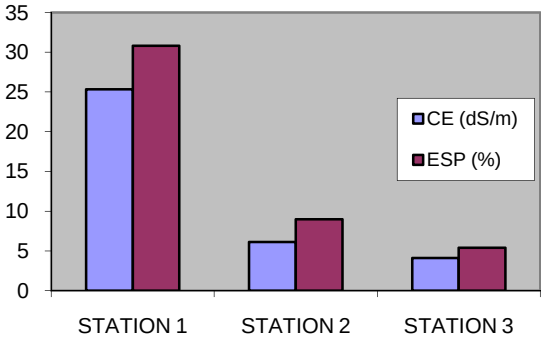

Figure n°4: Relation Cultural Practices/Salinity

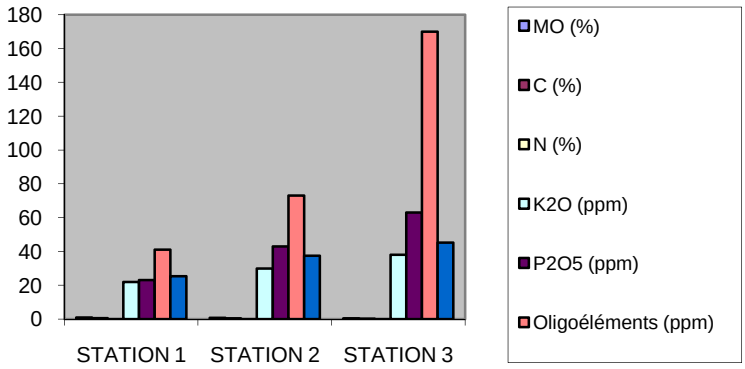

Figure n°5: Relation Cultural Practices/Fertility